

Sr. No. of Question Paper : 8053

Unique Paper code: 2513040027

Name of the paper: Optoelectronic Devices and Application (DSE)

Name of course: B.Sc.(H) Instrumentation

Semester: VIII

Duration: 3 Hours

Maximum Marks: 90

Instructions for Candidates:

1. Question No.1 is compulsory. All questions carry equal marks. Attempt any 5 questions in all.

2. Use of non-programmable scientific calculator is allowed.

- Q.1 (a) If electric field of a plane wave is $E = 100\sin(10^8t - 3x)$, find the wave velocity. (3)
(b) Define optical waveguide. Write any two classifications. (3)
(c) Differentiate between ordinary and extraordinary ray. (3)
(d) A wave has angular frequency 4×10^{15} rad/s and wave number 2×10^7 m⁻¹. Find phase velocity. (3)
(e) Define acousto-optic effect. (3)
(f) Describe about the semiconductor optical amplifier (SOA). (3)
- Q.2 (a) Derive the electromagnetic wave equation from Maxwell's equations in free space. (7)
(b) Derive Fresnel's equations for reflection and transmission at boundary. (7)
(c) Explain the phenomenon of optical tunnelling with a suitable diagram. (4)
- Q.3 (a) Derive V-number expression and determine whether fiber is single mode for $a = 5\mu\text{m}$, Numerical Aperture (NA) = 0.1, $\lambda = 1.3\mu\text{m}$. (7)
(b) What are fiber optic wave-plates? Explain how birefringence in optical fibers is used to realize quarter-wave and half-wave plates. (7)
(c) Distinguish between step-index and graded-index fiber. (4)
- Q.4 (a) Derive relation between phase shift and applied voltage in electro-optic modulator. (8)
(b) Explain circular and elliptical polarization mathematically. Calculate phase difference required for circular polarization. (8)
(c) Calculate modulation index if applied voltage is 2V and half-wave voltage, $V_\pi = 4\text{V}$. (2)
- Q.5 (a) Explain working of Semiconductor Optical Amplifiers (SOA). Calculate gain in dB for input 5 mW and output 100 mW. (7)
(b) Derive expression for photoconductive gain. Calculate gain for given carrier lifetime and transit time. (8)
(c) If threshold current is 20 mA and operating current is 50 mA, find excess current. (3)
- Q.6 (a) Derive Fresnel's equations for both s- and p-polarisations at the interface between two dielectric media. And also obtain the condition for Brewster's angle. (8)
(b) Design a half-wave plate for wavelength 633 nm with birefringence, $\Delta n = 0.008$. (7)

- (c) Calculate penetration depth if wavelength is 600 nm and incident angle is slightly greater than critical angle. (3)
- Q.7 (a) Explain heterojunction concept with band diagram. Calculate cut off wavelength and responsivity. (7)
- (b) Derive the frequency relation for third-harmonic generation (THG). (6)
- (c) Define LDR and its working principle. (5)